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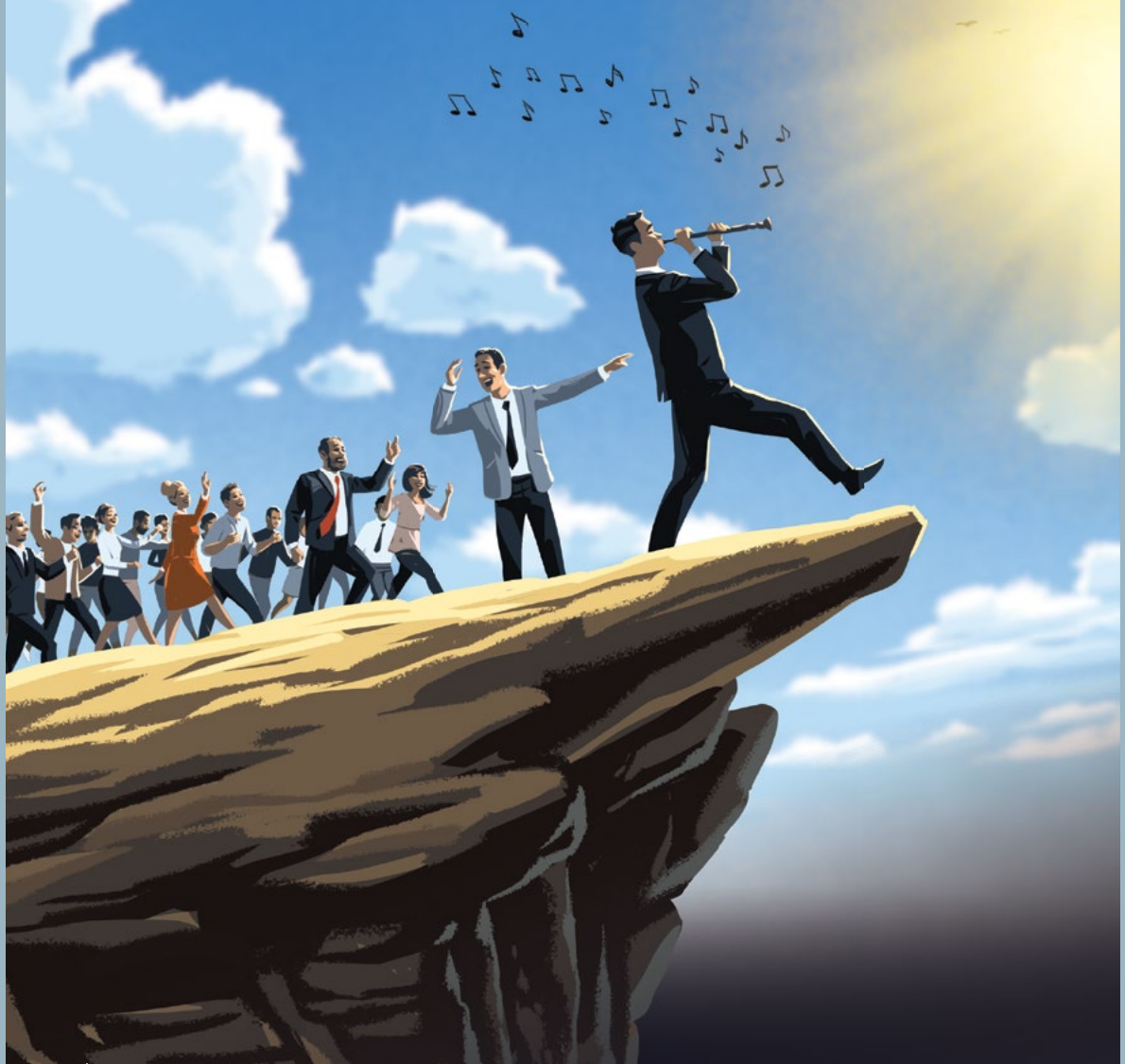

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SMART VILLAGES

Sir Brian Heap and Stephanie Hirmer

WE BEGIN upfront by offering a summary of the argument we make in these pages: one in ten people still live without electricity, and most of these are poor living in rural areas of developing countries. Until recently the concept of smart villages has been overlooked, as much attention has focused on urbanization. This could lead to rural populations being left behind. We posit that the quality of life in smart cities needs smart villages—not least for food security and the sustainable growth of productive enterprises in rural areas.

The Smart Villages model arising from the work of the Smart Villages Research Group in Africa, Asia, and Latin America is an integrated one. Energy access is seen as a key catalyst using a combination of renewable energy sources and the digital communication technologies of mobile phones and the internet. Access can then provide for community-led development in rural areas by the integration of healthcare, education, food security, environmental protection, and participatory democracy.

The smart villages concept is highly relevant to the United Nations 2030 Agenda for Sustainable Development and its flagship Sustainable Development Goals (SDG), particularly as related to providing affordable and clean energy, ending poverty, reducing inequalities, and ensuring good health and well-being. A few examples of smart villages are emerging in several developing countries. As yet, however, not all elements of integration have been incorporated into a single case.

So far, social impact investors have been slow to respond as opportunities exist for investment that could encourage new markets and wealth creation, aid job openings, and stem youth migration. Fostering a better quality of life in the rural communities of developing countries means that clients' money is used to do good as well as to generate returns.

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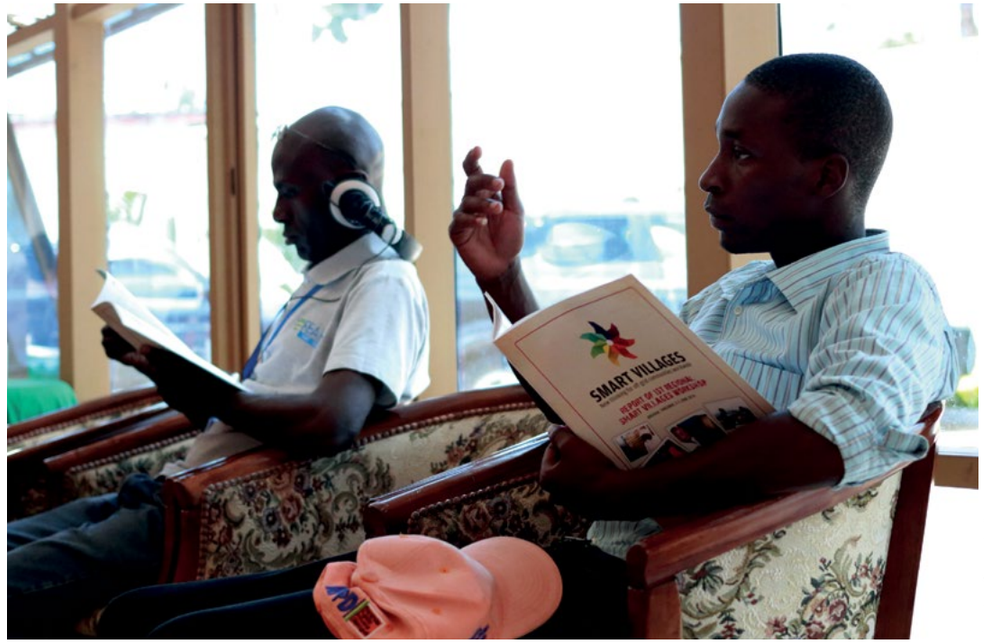

Photo: Smart Villages

A Smart Villages workshop in Tanzania

WHAT IS THE SMART VILLAGE CONCEPT?

Over 800 million—or 13 percent of the world population—still have no access to any form of electricity, and well over 1 billion people are not connected to national electricity grids. Most live in the countryside of developing countries, and most of these are poor. Energy-rich smart cities grab the headlines as engines for economic growth with their big data, Internet of Things, interoperability of devices, and artificial intelligence.

Yet smart cities need smart villages—not only for food security but the sustainable growth of enterprises and youth development. After all, this is where 47 percent of the world's population lives, and 70 percent of the world's poor. Climate change threatens further deterioration so that increased resilience of the poor has become a twenty-first century priority.

Could smart villages—a sister of smart cities—shift the balance of opportunities between cities and villages through technological advances and game-changing innovation? The concept is that access to renewable forms of energy, when linked with digital information and communication technologies (ICT), can act as a catalyst for development provided that a holistic approach is taken to harness the consequent opportunities for services and enterprise. In 2014 a workshop held at Cambridge under the auspices of the Smart Villages Initiative interrogated the new technologies that could fuel off-grid villages.

The smart villages concept is highly relevant to the UN 2030 Agenda its SDGs, particularly as related to providing affordable and clean energy, ending poverty, reducing inequalities, and ensuring good health and well-being.

Smart villages, in this context, do not have designer houses with the latest furnishings and garages with a fleet of BMWs. Rather, "smartness" comes from capturing energy from accessible and renewable sources such as photovoltaic solar power, wind power, and biofuels combined with mobile telephony and the internet. Electricity supplies basic needs such as lighting and cooking and facilitates better health and education. But more importantly, it leads to productive uses for pumping water, mechanized farming, small businesses and shops, and, finally, the luxury of cooling and heating, electrical appliances, and industrial employment typical of a modern society.

Former UN Secretary-General Ban Ki-moon described energy as the "golden thread" that weaves together economic growth, social equity, and environmental sustainability. The global investment in renewable energy last year exceeded $250 billion, a fraction of $1.8 trillion for total energy investment. The cost of achieving universal access is estimated to be around $52 billion per year in power generation and infrastructure. With improvements in digital platforms, renewables now make up around 90 percent of investment in new capacity through cheaper and more efficient lighting and appliances because of the declining costs of solar and decentralized solutions.

Examples

Gram Oorja is a social enterprise that created a microgrid in a remote hamlet of 39 households and 220 people located 140km from Pune, India, and an example of a smart village. Bosch Solar Energy AG and Shakti Foundation funded the microgrid comprising a decentralized solar power plant of 9.4 kW capacity that also provides power to a flour-grinding mill and two water pumps. Villagers have electricity throughout the day, with power for television sets and computers. Bills are collected monthly and the revenue used for the system's operations and maintenance. A village trust has been set up that gives a sense of ownership making the community self-reliant in meeting their electricity needs. The Build-Operate-Transfer model has now been used for over 200 households in 10 villages with microgrid costs that are recovered over five to seven years.

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Consider also the Maasai village of Terrat in Tanzania. Local leaders understood the village was at a crossroads. Realizing that a lack of economic opportunities was driving the younger generation into towns and cities, villager Martin Saning'o had dreams of the empowerment of his Maasai people using the main resources available of milk and livestock. He established the Institute for Orkonerei Pastoralists Advancement and grew jatropha and croton for biofuel to run three generators for milk processing. Supported by trained village operators, it has become overwhelmingly successful, with the daily production of 1,000 to 2,000 liters of milk resulting in exports of processed dairy products to niche national and regional markets. Martin Saning'o now works full time for the economic empowerment of the Maasai Pastoralists and its young people.

These are but two examples. Here are a five more. When Veronika Zavratnik and colleagues in Ljubljana, Slovenia, looked at the smart village concept they found aspects that were widely adopted in some form or other. In Ireland, the Cork Declaration 2.0 in 2016 uses the name of A Better Life in Rural Areas. In the 2018 Bled Declaration for a Smarter Future of the Rural Areas in EU, the digital economy addresses the rural youth drain by providing better conditions for farming enterprises. In Germany, the digital villages platform, Digitale Dörfer, is used in many regions in line with the country's general development goals. In the Arctic areas, the Smart Rural Community Cluster connects renewable technologies, natural resources and food production.

What's the Problem?

Universal electrification in developed countries can occur by the planned extension of the grid combined with local solutions and

sustained investment. The average duration of preparation, planning, and implementation of grid-based projects is nine years and if this were to continue, countries with low access would each only benefit from two to four World Bank projects by 2030. However, if there is a political will backed by appropriate policies and investment, major increases in electricity access can be achieved quickly.

Countries in Latin America and the Caribbean have made significant progress, as a result of which 95 percent of the population has access to energy. In China universal electricity access has been achieved over the last three decades starting from a low base. Transitions from low access to higher access status have occurred in two decades in Indonesia, Laos, and Vietnam. In India universal access is expected by the 2020s, with renewables projected to account for about 60 percent of those that gain access (with the significant caveat being that a village is deemed to be "electrified" if either 10 percent of households are connected or a transformer and distribution lines are set up in the inhabited locality). In sub-Saharan countries, however, the rate of improved energy access is slow, which means that 674 million people globally will still be without access to electricity in 2030. Nine out of ten of these will live in sub-Saharan Africa.

Energy access is seen as a key catalyst using a combination of renewable energy sources and the digital communication technologies of mobile phones and the internet. Access can then provide for community-led development in rural areas by the integration of healthcare, education, food security, environmental protection, and participatory democracy.

Extending the grid to rural communities can be prohibitively expensive, with estimates ranging from $6,000/km in densely populated Bangladesh to $19,000/km in countries like Mali. Geography and size of demand determine the cost per kWh so for public authorities or impoverished utilities the economic case is weak.

National grid extensions are not only expensive for many rural communities but generally very political processes because they are a tempting vote-winner for politicians. In India, officials find it difficult to say that a village will not get a national grid connection. Similarly, in Bangladesh a politician who backs minigrids—which are relatively unknown—is unlikely to garner as many votes as one who champions grid extension.

But an unplanned grid extension can undermine the confidence of investors in smart villages by creating uncertainty. A national energy access plan is needed to integrate national grid and off-grid planning setting out which areas are planned to get national grid access, or liquid petroleum gas (LPG) distribution networks for cooking, and on what timescale.

Off-grid Solutions

Off-grid solutions can be implemented worldwide on much shorter timescales and more cost-effectively, although, disappointingly, the World Bank's support for 'off-grid' projects over the period 2000 to 2016 accounted for just 2.5 percent of its electricity sector.

A realistic opportunity for off-grid smart villages is the 15kW minigrid, which represents a quick way towards developing a distribution network for clusters of villages. Small-scale electricity generation can be produced from solar photovoltaic panels, wind turbines, hydropower, biomass, and traditional fuel generators using kerosene or diesel, and hybrid systems.

Together with battery storage and diesel power, a minigrid can be built to overcome the intermittent nature of renewable energy sources. Further investment gives a more sophisticated smart minigrid with a management system that measures, monitors and controls electric loads coupled with a remote operation that optimizes the operation.

Minigrids also appeal because they overcome the problems of blackouts and help villagers to take a step onto the energy escalator, which starts with burning wood gathered from the locality and ends at the national grid. Minigrid solutions have now entered the mainstream and are here to stay, with $28 billion invested so far in more than 19,000 minigrids across 134 countries.

Six Elements of Smart Villages

Residents of smart village communities will lead healthy and more fulfilling lives, achieve their development potential, earn a viable living, and be connected to the wider world. The concept was already embraced in the UN's Sustainable Energy for All initiative that was launched in 2011 and reaffirmed in SDG7 (Energy). But studies of SDG interactions using a network approach show that a singular focus can lead to notable blind spots and risks unintended consequence. For example, traditional approaches to increasing agricultural productivity through intensification (SDG2) can lead to the loss of biodiversity and natural habitat affecting our ability to meet SDG15 (Life on Land). On the other hand, poverty alleviation (SDG1) and reducing inequalities can have compound positive effects on all SDGs.

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First, *health* (SDG3). Energy poverty has a very real and significant negative impact on the health of many villagers. Households lack access to potable water and a nutritious diet due to the cost of boiling water and cooking food. They resort to kerosene lamps and traditional cookstoves, which result in extremely harmful indoor area pollution and a high incidence of respiratory disease, particularly in women and children. It is estimated to contribute to 4.3 million premature deaths globally, primarily in low- and middle-income countries.

BP Energy, India—working with rural women's groups, the Covenant Centre for Development (CCD), and the Indian Institute of Science, Bangalore—created the highly efficient Oorja micro-gasifier cookstove. The stove, which uses pellets produced from agricultural waste, was the first model to be sold on a large scale and gives significant economic savings and a reduction in eye irritation and other health benefits.

Modern energy access can do much more by improving the health of rural dwellers by providing lighting, refrigerators, and sterilization for rural health centers, as well as supporting the use of mobile technologies for the diagnosis, monitoring, and treatment of patients. It can also empower health workers in gathering epidemiological data and help provide early warnings of the outbreaks of contagious diseases, such as cholera and the recent disastrous Ebola epidemic in West Africa.

The success of the Oorja cookstove inspired the development of other innovative last-mile sales and distribution models. Sakhi Retail in Maharashtra state boasts a distribution network of more than 830 local female rural retail entrepreneurs and seven warehouses covering 630 villages. The business model combines sales of cookstoves with solar lanterns, organic fertilizer, cattle feed supplement, SMS information services for farmers, and low-cost water purification and cooling kits; as a result, women entrepreneurs have witnessed a substantial increase in incomes.

Second, *education* (SDG4). A solar-powered internet school equipped with ICT technology provides an increasingly important medium of information for schools in the modern age and a definite pull-factor in terms of school attendance and the retention of good teachers. The mobile network coverage of many developing countries is extensive and rapidly increasing, with more than 100 educational learning platforms listed on the internet. Learning management systems make use of features such as "gamification" for game thinking and game design elements. In this way students are engaged in a sense of challenge, competition and fun through mini-games, points, badges, and rewards that involve students in new ways.

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Researchers at the University of Cambridge find that the provision of renewable energy in rural areas of India is particularly important for increasing employment opportunities for rural youth completing secondary school education. ICT-literacy of how to install and maintain renewable solar home systems provides young people with an asset whether they stay on and work on renewable energy projects in the new smart villages or move to smart cities.

Third, *food security* (SDG2). Approximately one in every seven people in the developing world is food insecure and unable to have access to enough food to sustain a healthy and active life. Smart villages have the potential to improve food security if farmers take advantage of solar power for pumps for irrigation systems, weather forecasting, cold-storage infrastructure, and agronomic and market information. They will be in a better position to gain from the benefits of agricultural modernization, including drone technologies, to capture more of the agricultural value chain.

Electricity access provides the opportunity to use ICT for the timely delivery of crops advised by information on market conditions. Better business decisions can be made with the increased bargaining power of rural producers over traders and wholesalers. In Malaysia, one of the early exponents of the smart village concept, the village of Rimbunan Kaseh increased household income by up to $500 per month as a result of an innovative and integrated agricultural system. A

public-private partnership between IRIS Corporation Berhard and MIGHT brings together government, industry and academia to produce high value crops, such as golden melon and jade perch fish. Using ICT, these products reach markets on Singaporean supermarket shelves.

Fourth, *economic activity and productivity* (multiple SDGs). Rural industries generally consist of small- and medium-sized enterprises focusing on retail, services, post-harvest processing, construction, manufacturing, and repair. Energy poverty hinders the establishment and development of enterprises through the lack of electricity to power tools and the inability to provide suitable lighting for industries to extend their working hours, while the lack of ICT access holds back rural industries through limiting their ability to connect with markets.

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By way of example, the tracking of products and inventories can be improved upon by radio frequency identification tags. The RFID tags can also be used to monitor the conditions of perishable foods, such as temperature and humidity, which benefits both the consumer and the rural seller. These tags are quickly becoming ubiquitous and by the end of 2017 the global RFID industry was worth approximately $13 billion.

Fifth, *stewardship of the environment* (multiple SDGs). Natural resources have a very direct impact upon communities. Smart villages seek to produce and use biomass in ways that are sustainable and renewable, do not deplete resources, and utilize them efficiently. "Smart" in this context means the sustainable intensification of food production by high-quality seed, the best practices of agronomy, and the protection of genetic resources.

Smallholder farmers can exercise a stewardship role for their local environment by remotely monitoring environmental indicators such as forest diagnostics, water quality, soil conditions, and landscape changes. This protects ecosystem services that are crucial to maintaining the earth's life-support systems and preserving the traditions of a country's culture; a 10 percent loss in biodiversity leads to a 3 percent loss in productivity.

Currently there is a lack of consideration of end-of-life products in rural communities because of the inability to recycle the incoming influx of solar panels, batteries and lighting products, as well as e-waste. Cradle-to-grave solutions are needed with incentives and take-back schemes to ensure that a village is truly smart about how it disposes of its hazardous materials.

Sixth, *quality of life and participatory democracy* (multiple SDGs). Patterns of behavior associated with tradition, value systems, ideologies, and heritage come under scrutiny during periods of deep societal change.

Ugandan coffee farmer and journalist Michael Ssali writes of the arrival of electricity in his village:

> In the past, if a farmer failed to sell some of the day's milk, he had to use firewood or charcoal to boil it to preserve it. Nowadays many farmers safeguard the milk by keeping it in refrigerators […]. Farmers' groups have set up coffee hullers and maize mills which use electricity, adding value to their produce. A farmer in our village uses electricity to pump underground water for his poultry farm and he also uses it to hatch the eggs and to keep the chicks warm.

An electronic voting system in India has expanded the meaning of social democracy to villagers previously disenfranchised from the political process. They become more aware through ICT of their social, economic, and political rights, engaging in governance processes and holding policymakers accountable.

Solutions to Persisting Barriers

The Smart Villages Initiative (SVI) started in 2014 and aimed to learn much more about the barriers to smart villages and to raise awareness of the new opportunities that exist to provide energy access. Over 40 events were held in Africa, Asia, and Latin America, including stakeholder workshops funded by the Templeton World Charity Foundation and the Cambridge Malaysian Education Development Trust.

A disaggregated and simple breakdown of an individual's energy requirement is a useful first step to see what energy is required in a smart village for each person to achieve positive health, education, economic, and quality of life outcomes. The chart below explains this in simple terms:

Level	Electricity use (or equivalent)	kWh per person per year
Basic human needs	Lighting, health, education, basic ICT	50 – 100
Productive uses	Agriculture, rural industry	500 – 1000
Modern society needs	Domestic appliances, cooling, heating, advanced ICT	2000

SVI has published online (www.e4sv.org) a description of five common barriers and ways to break them down. What follows is a summary of the findings.

First, *integration.* All stakeholders—villagers, entrepreneurs, NGOs, civil society organizations, policymakers and regulators, development organizations, financiers, researchers, and decisionmakers—have important roles to play, but they need to achieve much better levels of coordination and collaboration going forward. Strong support was expressed for the smart villages concept, seen as an integrated approach to rural development rather than a "technology-fix" only. The drivers should be the villagers themselves and external bodies should ensure that effective engagement with villagers underpins all their interventions.

Second, *investment.* Symbiotic private and public sector investment with enterprise growth capital funds are needed to de-risk and bridge the financial "valley of death." At the domestic level, investment is needed for practical appliances such as sewing machines, food mixers, and bread bakers, and at the village cooperative level for grinding equipment, welding tools, refrigerators, and water pumps. At the company level, accessing affordable working capital is essential as the banking sector's lack of familiarity with off-grid energy adds to the perception of risk and consequently high interest rates.

Third, *access to finance.* The financial community needs to familiarize itself with the issues associated with off-grid energy schemes. Enhanced rates of financing with affordable interest rates and innovative approaches to risk mitigation will help to build the confidence of the private sector to invest and maximize the leverage of government and donor funding. All stakeholders should work together to reduce the transaction costs for companies seeking finance. Potential mechanisms include bundling of projects for financing and the formation of cooperatives at the village level.

Fourth, *policy and regulatory framework.* Clear, supportive, and stable policy and regulatory frameworks, which bring together the interests of the relevant ministries, should be put in place. Governments provide the macro-institutional ecosystem within which policy frameworks and regulatory instruments for development occur, but effective indicators of short- and long-term impacts are required for both the public and private sectors. Government institutions must build their capacity in policymaking and regulation to attract private sector capital, and they need strong political backing based on careful analysis of the realities and not just wishful thinking. Simplification of licensing frameworks, reduction in red tape, and the provision of sufficient breathing space in respect to taxation regimes for businesses to get off the ground were frequently identified by stakeholders.

And fifth, *deficit correction.* Innovative sustainable training is a priority at all levels—ranging from local farmers, technicians, and engineers and product designers, to university researchers and local entrepreneurs trained to run a productive enterprise. For example, Sabah Women Entrepreneurs and Professionals Association selected a 40-year-old illiterate grandmother to go to the Barefoot College in Tilonia, India, for six months to learn by visual images how to install, repair, and maintain solar cells providing an electricity supply to her village serving some 100 villagers. The College scheme is built around grandmothers as experience shows that they will always return to their village!

MOTIVATIONS

Malaysia was one of the first developing countries to seize the opportunity to install off-grid energy generation by using diesel gensets to improve the quality of life in rural communities. By the Fourth Malaysia Plan in the late 1970s it was envisaged that rural electrification for Peninsular Malaysia would be completed by the year 2000.

By 2012 the International Energy Agency estimated that only 1.3 percent of the Malaysian rural population were without electricity. The more remote villages in Peninsular Malaysia and Sabah and Sarawak present greater challenges as bringing the indigenous population into the mainstream of development requires psychological and anthropological acumen. A recent bold new initiative, the 21st Century Village (21CV), was hatched in order to encourage youths to remain in the villages, and to work and start businesses in situ.

In sub-Saharan Africa, the decade-long Millennium Village Project was started in 2005 at 14 sites in 10 countries focused on agriculture and fertilizer support, health through vaccine supply, pest control and mosquito nets, education and the construction of schools, infrastructure including sanitation and roads, and business development through micro-credit and cooperative training. Crop yield increases of 85 to 350 percent and reductions in malaria incidence of over 50 percent were recorded. Founded by Jeffrey Sachs of Columbia University's Earth Institute, multimillion-dollar funding came from public and private sectors, but critics of this ambitious project point to limitations in the knowledge of local cultures.

Motivations differ and the EU's Action for Smart Villages launched in 2017 was concerned with smart rural transport and smart eco-social villages. The EU's Rural Development Policy for the 2014-2020 period—worth €100 billion covers 118 different programs. For instance, the European Spatial Planning Observation Network focuses on ways to deal with depopulation and enhanced job creation in rural areas of high unemployment and aging

populations as in the Northern Great Plane of Hungary, the Basilicata region of Southern Italy, and the Balkans. The FabLab network in Slovenia is, according to its own description, "enabling new opportunities for local people, especially the young, and local businesses, especially start-ups, providing them with the space and the infrastructure to gain high quality skills or realize their own business ideas."

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In Latin America, governments play a critical role since market forces alone cannot solve rural electrification. The Thermal Renewable Energy Fund in Peru promotes clean and efficient sustainable energy in rural and peri-urban populations.

In China, President Xi Jinping's "intelligent villages" initiative combines the use of use e-commerce, telemedicine, and intelligent monitoring to benefit farmers and transform traditional lifestyles. According to XinHuanet, villagers learn about local affairs, watch television, share bikes, and shop online via a smart village platform set up in 2015, with migrant workers encouraged to return to villages. Zeng Wei (32), who moved to a village in Fujian from neighboring Jiangxi Province is reported to have said in the same news report that "thanks to the internet, e-commerce, and better logistics systems, rural life is not much different from that in the cities. The countryside is a perfect place for freelance painters, writers, and designers who prefer to live close to nature."

TEMMING THE MIGRATION FLOW?

Paul Collier, author of *The Bottom Billion* (2007), argues that no country anywhere has developed without urbanization because of the way that a good city is able to harness economies of scale and specialization. Counterintuitively, the smart villages concept sees rural areas as places where there are real opportunities for income generating activities, employment, and economic development. Smart villages change the balance of opportunities between cities and villages, consequently repositioning the 'optimum' distribution of people between cities and villages. There are an estimated 740 million internal migrants and around 270 million international migrants in the world. The prevailing trend of urbanization means that Europe—a demographically waning continent—faces massive migration from sub-Saharan Africa, which is expected to see both the greatest increases in youth populations and sharpest rises in urbanization. Consider that Kinshasa, the capital of the Democratic Republic of Congo, is expected to become the world's largest city by 2075.

Without the right investments, the concentration of young population will be a force for political instability: studies remind us that 80 percent of civil conflicts from 1970 to 1999 took place in countries where the majority of the population was under the age of 30 and that almost 40 percent of those who joined rebel movements say that a lack of employment opportunities was a motivating force in their decision.

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For smart villages to thrive, agricultural development is key to developing stability in much of sub-Saharan Africa, where farmland is producing below its capacity and wise investments stand to reap great rewards.

Smart villages could help to address the migration issue by making rural communities places where people can prosper, and many governments are beginning to realize this with policies to improve rural infrastructure and services, together with pro-poor laws and regulations. Plans have yet to emerge for the application of the concept in migrant camps, where there is a desperate need for energy as a catalyst for building smart villages. Host countries would need to be persuaded of the transitory rather than permanent nature of such developments.

INVESTOR OPPORTUNITIES

Proto-smart villages are under construction in several developing countries, though as yet not all elements of integration have been incorporated into a single prototype. Sunmoksha Ltd. was the first to launch a smart village in Chhotkei, a small remote village in India's state of Odisha situated amidst rich natural resources. It was previously without electricity and had a primary livelihood of rain-fed paddy cultivation once a year. Private investment provided a 30kW solar-powered Smart Nanogrid™ to meet the energy demands of 140 households, 20 streetlights, a temple, and three community centers.

Cloud-based controls manage metering, billing, and end-user pay-as-you-go payment, with alerts to "cut off" if unpaid. Electricity is available for irrigation pumps and micro-enterprises

such as poultry, stitching, rice-puff machines, refrigerators, and welding machines that enables value-addition to agriculture and employment for local youth to help ensure the project's sustainability. Within a year, children started to study in the evening, women and adults have access to light and entertainment, and young people to business opportunities. A mother in the village aptly summarized developments: "now," she says, "we have hope for the future!"

The Parliamentarian's Model Village Scheme launched in India in October 2014 mandated each parliamentarian to adopt three rural villages and transform them into smart villages by 2019. This excellent initiative has been slow to materialize due to a lack of investment—even though the Indian government decreed that high-value companies spend at least 2 percent of the previous three years' average net profits on Corporate Social Responsibility (CSR) initiatives. In 2016 a sum estimated to be well in excess of $5bn was available. Renewable energy technologies have to be an attractive priority for small-scale farming communities in the country's 600,000 villages.

The European Agricultural Fund for Rural Development for the period 2014-2020 is investing €100 billion (with a further €61 billion leveraged by member states). It is one of the largest schemes of its type anywhere in the world, seeking to turn "momentum into action."

Yet, it fails to grasp the significance of energy as a catalyst of development, or the value of an integrated approach. Perhaps this explains why impact investors have been late to see the potential opportunities in developing countries of community-led smart villages initiatives that foster innovation, wealth creation, entrepreneurship, social development, and markets.

A big picture envisaged in an August 2019 *Financial Times* essay concerns the emerging revolution among asset managers in "splashing of cash" to gain a foothold in the environmental, social, and governance (ESG) investing sector now that clients demand that their money is used to do good as well as to generate returns. Incorporating ESG into strategy means investing in technology and combining it with an assessment of a company's financial stewardship.

The Smart Villages Research Group led by Bernie Jones at Oxford, together with organizations such as the Brussels-based Alliance for Rural Electrification and the UN's Sustainable Energy for All initiative encourage the collection and reporting of technological and social impact data to advise investment activity. The Group also proposes to test the concept further by the expansion of clusters of exemplar villages in Africa, Asia, and Latin America, selecting 100 villages each twinned with a sufficiently similar village that can act as a control. Initial funding for each pair will provide minigrid installation but only one will have the comprehensive package of interventions on services, connectivity, and productive enterprises considered necessary to achieve the level of development aimed for in smart villages.

Simon Trace, former CEO of Practical Action, observes that our society chooses to subsidize the coal, gas, and oil industries that cause harm to local populations by air pollution and the effects of climate change including floods, droughts, and storms. Such harmful effects are estimated to cost over $5 trillion each year, in comparison with a woefully low investment in renewable energy of about $250 billion.

We conclude with his assessment:

> It is an immense injustice that humanity has not managed to ensure universal access to technologies critical to achieving a minimum reasonable standard of living, technologies that have generally been in existence and use for decades and, in some cases, centuries. Technology justice, in this respect, must mean establishing a global governance process that ensures these gaps in technology access are addressed and closed—something it has long been in our power to do.